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<b>(21) International Application Number:</b> PCT/GB98/02766 <b>(22) International Filing Date:</b> 14 September 1998 (14.09.98) <b>(30) Priority Data:</b> 9719459.1 12 September 1997 (12.09.97) GB <b>(71) Applicant (for all designated States except US):</b> GOVERNOR AND COMPANY OF THE BANK OF ENGLAND [GB/GB]; Threadneedle Street, London EC2R 8AH (GB). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> McCALLUM, Allister, Ian [GB/GB]; Bank of England-Printing Works, Langston Road, Loughton, Essex IG10 3TN (GB). <b>(74) Agents:</b> LAWRENCE, Malcolm, Graham et al.; Hepworth Lawrence Bryer & Bizley, Merlin House, Falconry Court, Bakers Lane, Epping, Essex CM16 5DQ (GB).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> ITEMS REQUIRING VERIFICATION  <b>(57) Abstract</b>  An item requiring verification comprising a substrate printed with a first printed ink image visible to the human eye under normal white light irradiation through the reflection of colours produced by the subtractive process and a second printed ink image only visible to the human eye under irradiation by radiation of non-visible wavelengths by additive emission of lights of visible wavelength, characterised in that the second printed ink image is a record of a polychromatic reference composition recorded in the colours of said reference composition, and in that the pixels of the second printed ink image are each comprised of one or more inks which are colourless under visible light irradiation and which contain one or more dopants which have a coloured fluorescent response to said radiation of non-visible wavelength, said pixels collectively forming said record of said polychromatic reference composition having a reference quality, whereby mental comparison by an observer between said polychromatic reference quality image and the colour composition of a remembered image of the polychromatic reference composition enables the observer to determine that the item is authentic. Preferably the item requiring verification is a bank note comprising further security features and preferably the pixels of the second printed ink image each comprise varying amounts of three inks having fluorescence responses in the red, green and blue colour ranges.		

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## Items Requiring Verification

- The invention relates to items requiring verification having an ordinarily invisible polychromatic printed image of a polychromatic reference composition which polychromatic printed image enables an observer of the item to determine authenticity under the irradiation of non-visible wavelength and represents a challenge to counterfeiter.

- In images whose colour is determined by subtractive colour composition, particular component colours are subtracted from white light reflectively incident upon a surface leaving the reflected colour as that which is ordinarily observed. The normal mixing of paints or inks is an example of subtractive colour mixing. For example, red paint appears red because when white light is incident on it, it absorbs all colours except red, which it reflects. Thus, when paints of different colours are mixed, more components of white light are absorbed and fewer reflected. In conventional colour printing, this effect is utilised by the judicious use of three coloured inks (yellow, magenta and cyan). By adjusting the relative amounts of these three inks, the printer can create almost any colour he wishes; white is a manifestation of no print at all whilst black (at least in theory) is the chromatic response of printing all three colours at full strength, when all incident light is absorbed and none reflected.

- In the case of a television screen, small elements of red, green and blue light are emitted as a result of the excitation of surface deposits by an energetic beam of particles. A television screen is an example of a system which produces colours by additive emission of visible light as opposed to subtractive reflection of light. By adjusting the relative brightnesses of these coloured lights, almost any colour can be created on the screen; white is a manifestation of all three coloured lights at full-strength whilst black is all three unactivated.

It is customary in the printing of security documents (for example banknotes) to include security images which are difficult for counterfeiters to copy. These images are intended to act as security devices to verify the authenticity of the security documents. Such images are often complex and produced by conventional subtractive colour mixing.

The usefulness of security images depends upon the observer being able to recognise counterfeit copies of them. Ideal security images are therefore both difficult to copy and easy to evaluate for accuracy. In practice this evaluation or judgement is made more difficult because there is not often a true copy of the original security image (the reference image) present when this evaluation is carried out. Thus the evaluation becomes a mental comparison with a remembered image. It is recognised that the ease of this mental comparison depends upon the quality of the reference image because the more memorable and more "real" the reference image is, the easier the mental comparison becomes. In practical terms this means that the reference image needs to be very accurate, and preferably related to an object or scene in which the colours are familiar and critical to the normal perception of that object or scene.

Images visible only when irradiated in a particular way are desirable in particular because of the availability of very high quality colour reproduction equipment, such as photocopiers which are increasingly being used by counterfeiters. Such images are generally invisible to the photocopier or other reproduction equipment (and are therefore not transferred at all to the counterfeit document) or they transfer as an easily detectable additional image visibly signifying counterfeiter.

Therefore there is a need for the production of fluorescent security images having the most natural colours possible. We have now found that such

images may be produced by additive colour emission of fluorescent dyes when viewed under suitable radiation.

This invention therefore provides an item requiring verification comprising a  
5 substrate printed with a first printed ink image visible to the human eye under normal white light irradiation through the reflection of colours produced by the subtractive process and a second printed ink image only visible to the human eye under irradiation by radiation of non-visible wavelengths by additive emission of lights of visible wavelength,  
10 characterised in that the second printed ink image is a record of a polychromatic reference composition recorded in the colours of said reference composition. The pixels of the second printed ink image are each comprised of one or more inks which are colourless under visible light irradiation and which contain one or more dopants which have a coloured  
15 fluorescent response to said radiation of non-visible wavelength, said pixels collectively forming said record of said polychromatic reference composition having a reference quality, whereby mental comparison by an observer between said polychromatic reference quality image and the colour composition of a remembered image of the polychromatic reference  
20 composition enables the observer to determine that the item is authentic.

The invention further comprises a method of verifying the authenticity of an item of the invention by viewing the item under radiation of non-visible wavelengths, so that the pixels of the second printed ink image fluoresce to  
25 produce a polychromatic reference quality image; and comparing the polychromatic reference quality image so formed with the polychromatic reference composition, either by direct visual comparison with the original or a copy of the polychromatic reference composition, or by mental comparison with a remembered image of the polychromatic reference  
30 composition.

In the items of the invention, the first printed ink image may comprise a polychromatic image, a monochromatic image or a black image, wherein no visible light is emitted (eg black type print) or combinations thereof, or it may be replaced by a relief pattern (for example, in clothing or paper products) or a die cut pattern (ie fretted or perforate).

Items that may be protected by means of the present invention include any printed items of value or requiring means of verifying its authenticity such as security documents, articles of packaging or articles of clothing.

10

Articles of clothing that may be protected by the present invention include any items that the manufacturers wish to authenticate as being produced only by themselves or which are required to produce coloured images under unusual lighting conditions, eg under the ultra-violet lighting used in dance halls, etc. In order to produce such articles of clothing, the second printed image may be applied by conventional methods, for example, by screen printing or transfer printing using the fluorescent inks described below.

Items of packaging that may be protected by the present invention include packaging for any items for which it is desired to authenticate the origin thereof, ie items of financial value or for which safety considerations apply, eg pharmaceuticals, motor parts, aircraft parts, cosmetics, perfumes, cigarettes or computer software. The items of packaging will comprise conventional packaging substrate materials and the second printed image may be applied by any conventional printing techniques using the fluorescent inks described below.

Security documents that may be protected by the present invention include financial tender, tickets, stamps, visas, passports, entry permits, driving licenses, benefits agency documents, identification cards, labels, membership cards and credit cards. Examples of labels include any labels

that may be applied to an item to guarantee its authenticity, eg bottle labels, food labels or clothing labels (eg hang tags). Such labels could be applied directly to the goods or be an integral part of the packaging thereof. Examples of tickets include lottery tickets, transport tickets (eg airline tickets) or tickets to sporting or musical events.

Items of financial tender that may be protected by the present invention include banknotes, share certificates, bank bonds, bank cheques, travellers cheques, gift vouchers, certificates of deposit or postal orders.

10

Where the items of the invention are security documents they may be produced on any conventional substrate materials, for example paper or printable plastic .

15 Where the items of the invention are financial tender, it is preferred that the substrate is paper (optionally watermarked) but it could also be a specially produced plastic material such as is used for Australian banknotes, and that the first printed ink image comprises indicia identifying said document as financial tender.

20

Most preferably the items of the invention are banknotes, but they could also be any other item whose validity may be questioned.

Where the items of the invention are security documents they may also  
25 comprise further conventional security devices including transparent portions, watermarks, security threads, embossed images and the like.

Where the items of the invention are security documents they may optionally further comprise one or more areas of embossed images each of  
30 which said areas may be registered with at least part of the first printed ink image and/or at least part of the second printed ink image.

Preferably in the items of the invention the pixels fluoresce in response to ultra-violet radiation but the invention is not limited to these wavelengths. It is known that visible emissions can be obtained from certain materials  
5 when irradiated by wavelengths in the infra-red regions of the spectrum for example. It is further known that coloured emissions can be obtained by the application of heat or pressure.

A further embodiment is that the second printed ink image of the items of  
10 the invention is a record of a polychromatic reference composition which is a natural or unnatural composition of objects the colour composition of which is familiar to human sight and comparable by an observer from a memory of said colour composition with a reproduction thereof with such high acuity that discrepancy between said composition and said  
15 reproduction is discernible without conscious resolution of the discrepancy into individual elements.

The invention may have the added advantage that the fluorescent image can be readily compared with the image on a computer monitor or television  
20 screen. It is often difficult to compare accurately an image produced by a printed subtractive coloration process and that produced by an additive coloration process as seen on a computer screen because of the different brightness levels and processes involved.

25 Examples of suitable polychromatic reference compositions include all objects whose natural colours are well-known, such as rainbows, traffic lights, fruit, flowers, birds, portraits, scenes featuring grass, leaves, sky, sea etc.

30 In the items of the invention, the second printed ink image may be superimposed with a printed image which is visible under white light



irradiation. The printed image which is visible under white light irradiation may be at least in part a portion of said first printed ink image and relates to the second printed image in an obvious manner.

- 5 The inks of said second printed image which are colourless under white light irradiation preferably each comprise an ink carrier (preferably an organic solvent), a pigment binder and one or more dopants which have a coloured fluorescent response to radiation of a non-visible wavelength, they may also optionally comprise one or more further components selected from
- 10 electrolytes, pH adjusting agents, humectants, biocides and defoamers.

- Dopants for use in the items of the invention may have any colour response to radiation of a non-visible wavelength so long as they combine such that the pixels of the second printed ink image collectively manifest
- 15 polychromaticity to such radiation. Preferably at least one of the dopants has a green, red or blue colour fluorescent response to said radiation. More preferably the dopants include at least one first dopant having a green fluorescent response to said radiation, at least one second dopant having a red fluorescent response thereto and at least one third dopant having a blue
- 20 fluorescent response thereto.

Preferably the first, blue, dopant is Garobrite OB available from Croxton and Garry.

- 25 Preferably the second, red, dopant is M327B available from Giesecke and Devrient or is CD120 available from Riedel de Haen AG.

Preferably the third, green, dopant is Cartax cxdp available from Sandoz

- 30 A process for producing items according to the invention comprises:-

- a) selecting a suitable polychromatic reference composition, preferably in the form of a photographic print or transparency;
- b) scanning the polychromatic reference composition to separate it into its primary colour components;
- c) producing printing plates corresponding to each of the colour components; and
- d) printing finished security documents using the plates prepared in step c).

The process of making a normally visible reproduction of the reference composition in a) is a well-known technique in the print trade. The conventional way in which a polychromatic composition is depicted is by the subtractive mixing of yellow, magenta and cyan coloured inks.

In this invention, inks which are invisible under white light radiation are caused to emit red, green and blue light when stimulated by non-visible wavelength irradiation. The polychromatic reference composition becomes distinguishable when the red, green and blue lights are mixed additively.

Alternatively steps a) and b) above may be combined in that the polychromatic reference image might be generated directly by additive colour mixing, for example on a computer monitor screen, so that the relative colour components are automatically determined.

To be useful as a means of verifying authenticity, the people responsible for validating the items of the invention (eg bank tellers) should preferably have seen a copy of the polychromatic reference composition which would preferably be a genuine banknote or other document known to be genuine.

This copy may be either an additive colour image, such as that produced on a computer monitor or television screen, or a conventional subtractive colour image. However, it is important that it is as accurate a copy of the reference image as is possible. Alternatively, a polychromatic reference composition may be chosen which is so well recognised that it is not necessary for it to be seen in this context, merely referred to.

The invention will now be illustrated by reference to the following Example:-

10 Example

Banknotes having UV-visible polychromatic images of reference quality were produced according to the following procedure.

A representation of a bowl containing an orange, a banana and an apple was chosen as the polychromatic reference image. This representation was scanned by means of a commercially available scanning device (eg a Dainippon Screen DT-S1030AI ) to separate it into its blue, green and red components. These were then saved, with minor enhancements, in Adobe Photoshop. Other similar colour editing software would be equally appropriate. The saved file was then sent to an imagesetter which produced Red, Green and Blue film separation positives at an appropriate resolution. These positives were then duplicated to produce right reading emulsion down positives. They were then positioned in register to each other on 3 separate negative working offset litho plates; background masking being required to stop the whole plate printing. The plate with the Red separation image was printed using invisible fluorescent Red ink. The plate with the Green separation image was printed using invisible fluorescent Green ink. The plate with the Blue separation image was printed using invisible fluorescent Blue ink.

30

It was essential to ensure that all images were in good register to each other. Printing was carried out on banknote grade paper, but any non-fluorescing paper could be used.

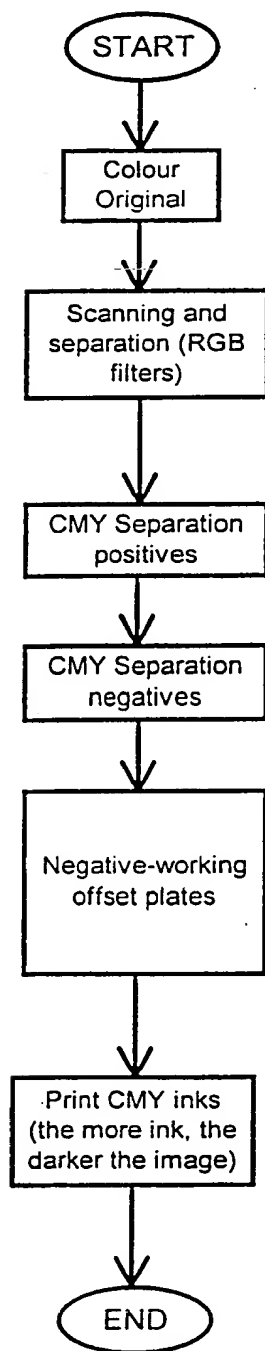
- 5 Test banknotes were printed using standard banknote paper on a Super Simultan 212 banknote press with test banknote images which had all the important attributes of a banknote which is normally issued to the public. A full colour UV-visible image was also incorporated using the above 3 plates into this 'banknote' image using the same plates as were used to  
10 print the note images.

- The UV-visible inks used had the same basic components as the inks used to print the visible conventional parts of the image but carried the necessary special dopants ie Garobrite OB (blue), CD120 (red) and Cartax cxdp  
15 (green).

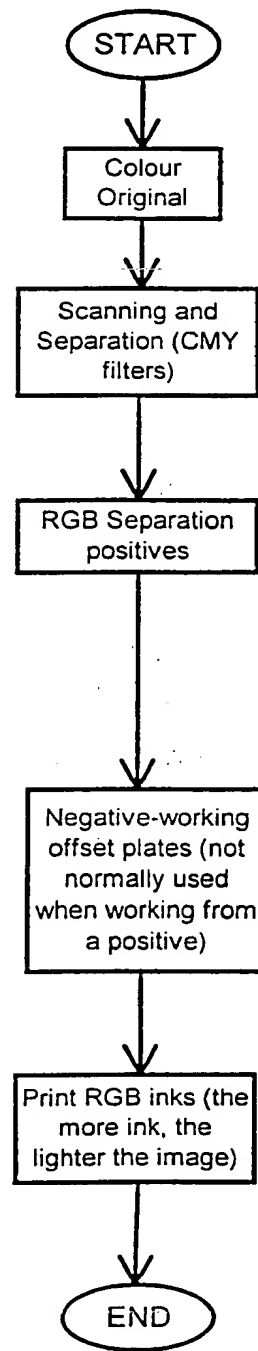
- Under UV illumination from a standard long wave desk-top lamp the banknotes exhibited a clear image of the polychromatic reference image such that it could be easily compared for accuracy to the original image.  
20

Flow Diagram to illustrate the differences between conventional full-colour reproduction and full-colour fluorescence reproduction:

Conventional Process



Full-Colour Fluorescence Process



The invention includes within its scope an item requiring verification and comprising a substrate printed or otherwise formed with a first eg printed ink image visible to the human eye under normal white light irradiation through the reflection of colours produced by the subtractive process or  
5 otherwise formed in a shape or configuration perceptible thereto under such conditions, and a printed ink verification image only visible to the human eye as an image of reference quality under irradiation by radiation of non-visible wavelengths by additive emission of lights of visible wavelength, characterised in that the verification image is a record of a polychromatic  
10 reference composition recorded in the colours of said reference composition, and in that the pixels of the verification image are each comprised of one or more inks which are colourless or imperfectly perceptible under visible light irradiation and which contain one or more dopants which have a coloured fluorescent response to said radiation of  
15 non-visible wavelength, said pixels collectively forming said record of said polychromatic reference composition, said record having a reference or high quality, whereby mental comparison by an observer between said polychromatic reference quality image and the colour composition of a remembered image of the polychromatic reference composition enables the  
20 observer to verify the item as authentic. In an embodiment of the invention, mental comparison by an observer between said polychromatic reference quality image and the colour composition of a mentally perceived image of the polychromatic reference composition enables verification.

## CLAIMS:

1. An item requiring verification comprising a substrate printed with a first printed ink image visible to the human eye under normal white light irradiation through the reflection of colours produced by the subtractive process and a second printed ink image only visible to the human eye under irradiation by radiation of non-visible wavelengths by additive emission of lights of visible wavelength, characterised in that the second printed ink image is a record of a polychromatic reference composition recorded in the colours of said reference composition, and in that the pixels of the second printed ink image are each comprised of one or more inks which are colourless under visible light irradiation and which contain one or more dopants which have a coloured fluorescent response to said radiation of non-visible wavelength, said pixels collectively forming said record of said polychromatic reference composition having a reference quality, whereby mental comparison by an observer between said polychromatic reference quality image and the colour composition of a remembered image of the polychromatic reference composition enables the observer to determine that the item is authentic.
2. An item as claimed in claim 1 wherein said pixels of said second printed ink image are pixels which have a coloured fluorescent response to UV-radiation.
3. An item as claimed in claim 1 wherein said pixels of said second printed ink image are pixels which have a coloured fluorescent response to infra-red radiation or other stimuli.
4. An item as claimed in any of claims 1 to 3 wherein said second printed ink image is a record of a polychromatic reference composition which is a natural or unnatural composition of objects the colour composition of which is familiar to human sight and comparable with a

reproduction thereof by an observer from a memory of said colour composition with such high acuity that discrepancy between said composition and said reproduction is discernible without conscious resolution of the discrepancy into individual elements.

5

5. An item as claimed in any preceding claim wherein said second printed ink image is visible to the human eye under irradiation by radiation of non-visible wavelength and is superimposed with a printed image which is visible under white light irradiation.

10

6. An item as claimed in claim 5 wherein said printed image which is visible under white light irradiation is at least in part a portion of said first printed ink image.

15

7. An item as claimed in any preceding claim wherein said inks which are colourless under white light irradiation comprise an ink carrier, a pigment binder and one or more of said dopants.

20

8. An item as claimed in any preceding claim wherein the second printed ink image is composed of pixels which collectively have a fluorescent response in at least two-colours to said radiation of visible or non-visible wavelength.

25

9. An item as claimed in claim 12 wherein the pixels of said second printed ink image collectively have a fluorescent response to said radiation of visible or non-visible wavelength in three colours.

10. An item as claimed in claim 9 wherein the three colours of the fluorescent response are red, blue and green.

30



11. An item as claimed in any one of claims 7 to 10 wherein the pixels of the second printed ink image include Garobrite OB as a dopant having a blue fluorescent response to said radiation of non-visible wavelength, and/or CD120 as a dopant having a red fluorescent response thereto, and/or Cartax cxdp as a dopant having a green fluorescent response thereto.
12. An item as claimed in any preceding claim which is a security document, an article of packaging material or an article of clothing.
13. An item as claimed in claim 12 which is an article of packaging for pharmaceuticals, motor parts, aircraft parts, cosmetics, perfumes, cigarettes or computer software.
14. An item as claimed in claim 12 which is a security document selected from financial tender, tickets, stamps, visas, passports, entry permits, driving licenses, benefits agency documents, identification cards, labels, membership cards or credit cards.
15. An item as claimed in claim 14 which is a label selected from bottle labels, food labels or clothing labels.
16. An item as claimed in claim 14 which is financial tender selected from banknotes, share certificates, bank bonds, bank cheques, travellers cheques, gift vouchers, certificates of deposit or postal orders.
17. An item as claimed in claim 16 wherein said substrate is an optionally watermarked paper substrate or a plastics material and carries as said first printed ink image indicia identifying said document as financial tender.

18. An item as claimed in claim 16 or claim 17 and which is a banknote or a credit card.
19. An item as claimed in any preceding claim and including one or more  
5 areas of embossed image optionally registered with at least part of said first printed ink image and/or at least part of said second printed ink image.
20. A security document comprising a substrate printed with a first printed ink image visible to the human eye under normal white light  
10 irradiation through the reflection of colours produced by the subtractive process and a second printed ink image visible to the human eye under irradiation by radiation of non-visible wavelengths by additive emission of lights of visible wavelength, characterised in that the second printed ink image is a record of a polychromatic reference composition recorded in the  
15 colours of said reference composition, and in that the pixels of the second printed ink image are each comprised of one or more inks which are colourless under visible light irradiation and which contain one or more dopants which have a coloured fluorescent response to said radiation of non-visible wavelength, said pixels collectively forming said record of said  
20 polychromatic reference composition having a reference quality, whereby mental comparison by an observer between said polychromatic- reference quality image and the colour composition of a remembered image of the polychromatic reference composition enables the observer to determine that the security document is authentic.
21. An item requiring verification comprising a substrate printed with a printed ink image only visible to the human eye under irradiation by  
25 radiation of non-visible wavelengths by additive emission of lights of visible wavelength, characterised in that the printed ink image is a record of a  
30 polychromatic reference composition recorded in the colours of said reference composition, and in that the pixels of the printed ink image are

- each comprised of one or more inks which are colourless under visible light irradiation and which contain one or more dopants which have a coloured fluorescent response to said radiation of non-visible wavelength, said pixels collectively forming said record of said polychromatic reference composition having a reference quality, whereby mental comparison by an observer between said polychromatic reference quality image and the colour composition of a remembered image of the polychromatic reference composition enables the observer to determine that the item is authentic.
22. An item as claimed in claim 21 wherein the substrate also bears an image visible to the human eye under normal white light irradiation, the said visible image comprising a printed ink image, a relief pattern, a die cut pattern or a combination therefore.
23. An item requiring verification substantially as described herein with reference to the examples.
24. A method of verifying authenticity of an item as claimed in any previous claim by viewing the item under radiation of non-visible wavelengths so that the pixels of the second printed ink image fluoresce to produce a polychromatic reference quality image; and comparing the polychromatic reference quality image so formed with the polychromatic reference composition, either by direct visual comparison with the original or a copy of the polychromatic reference composition, or by mental comparison with a remembered image of the polychromatic reference composition.

# INTERNATIONAL SEARCH REPORT

Int'l. Application No  
PCT/GB 98/02766

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B41M3/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B41M B42D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 10958 A (DE LA RUE THOMAS & CO LTD. ;CHATWIN CHARLES EDWARD (GB)) 27 March 1997  see page 1, line 36 - page 2, line 4 see page 6, line 33 - page 7, line 16 see the whole document	1-4, 7-9, 12, 14, 16, 18, 20-22, 24
Y	---	6
E	WO 98 40223 A (POLAROID CORP) 17 September 1998  see page 4, line 15 - line 27 see page 6, line 19 - line 24 see page 8, line 17 - line 22 see figure 2  ---	1-10, 12-14, 16-18, 20-22, 24
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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 98/02766

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 897 300 A (BOEHM MICHAEL) 30 January 1990 see claims ---	1-24
Y	EP 0 202 902 A (ROYAL DOULTON LTD) 26 November 1986 see claim 8 see the whole document	6
A	---	1-24
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
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